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The effectiveness of low level laser therapy and acupuncture as interventions for temporomandibular joint disorders in adults: a systematic review and meta-analysis

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Abstract

Temporomandibular joint disorders (TMD) encompass a range of disorders of the temporomandibular joint, the masticatory muscles and other associated structures. The main symptom of TMD patients is pain within the orofacial region. The objective of this review is to compare the effectiveness of low level laser therapy (LLLT) and acupuncture as interventions for TMD. Randomized controlled trials comparing LLLT versus PLT and real acupuncture versus placebo acupuncture were included within the review. The primary outcome was subjective pain intensity expressed via a numerical visual analogue scale (VAS) upon palpation of the masseter muscles. Secondary outcomes include pain intensity via VAS upon palpation of other areas of the myofascial region; the lateral pole of the condyle, the pre-auricular region and the external auditive meatus. The author performed the data extraction, analysis and the risk of bias assessment. 10 studies (n=317) were included in assessment of LLLT vs PLT. LLLT was found to be statistically more effective than PLT in reducing subjective pain intensity upon palpation. Six studies (n=165) were included in the assessment of real acupuncture versus placebo acupuncture. Acupuncture was not statistically more effective in reducing subjective pain compared to placebo acupuncture in TMD patients. The I^2 statistic described the percentage of variability in the effect estimates from the different subgroups which shows considerable heterogeneity across the subgroups. In comparing both treatments as measures for managing pain intensity in patients with TMD, LLLT significantly reduced subjective pain on palpation of the masseter muscles, lateral pole of the condyle, the pre-auricular region and the external auditive meatus. Acupuncture therapy, on the other hand, did not significantly reduce pain intensity upon palpation of the masseter muscles in patients with temporomandibular disorders. The results suggest that LLLT is a more effective non-invasive intervention for TMD.

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Background

Description of the condition

Temporomandibular disorders (TMD) encompass a wide range of disorders of the temporomandibular joint (TMJ), the masticatory muscles as well as their associated structures and has been identified as the leading cause of pain in the orofacial region excluding dental pain (Herranz-Aparicio et al. 2013). The vast majority of patients with TMD also present symptoms of pain dysfunction syndrome which can be a combination of any of the following signs and symptoms: pain on palpation of the TMJ, pain on palpation of associated muscles, restriction or deviation of mandibular movement, joint sounds and headaches (Gray et al. 2003). The main symptom expressed by patients suffering from TMD is pain within the masticatory muscles which can have a debilitating effect on patient's lives (de Moraes Maia et al. 2011). Up to 33% of the population may experience TMD within their lifetime which can have serious implications within a person's life (Wright and North 2009). The two matching temporomandibular joints on either side of the skull located just in front of the ears are the source of pain in temporomandibular joint disorder patients.

Many of the symptoms of TMD are caused by physical stress of the cartilage, muscles, nearby ligaments as well as the teeth. For numerous patients the cause is often not known but may be due to an improper lining of the teeth, grinding of teeth at night (bruxism) or even poor posture (A.D.A.M 2014). Common pathologies that cause pain within the TMJ include disc displacement and degenerative joint diseases such as arthritis and arthrosis which is supported by evidence of the joint being a very heavily loaded structure (Cairns 2010). Extreme loading of the joint has been found to initiate peripheral mechanisms which cause pain by the mechanical stimulation of nociceptors and an up-regulated release of substance P and calcitonin gene-related peptide (CGRP) (two neuropeptides) and proinflammatory cytokines such as tumour necrosis factor alpha (TNFα) and interleukins 6 and 8 (Cairns 2010). The inflamed joint has been also been found to increase the nociceptive input which is effective in prompting central sensitization which may contribute to an increased association of inflammation within the TMJ causing pain (Yu et al. 1996; Ohrbach 2010).

Description of the intervention

The theory of using LLLT was first introduced by Mester and colleagues in 1968 (Mester et al. 1968). Since then, there has been considerable development in the clinical applications of this therapy as is evident in its application to a wide range of disorders, from bone healing to pain reduction (Rola et al. 2014). The use of lasers in treating patients has continuously improved since the late 60's and is now a very common practice within dentistry to relieve pain and inflammation. Lasers with a higher output can damage and even destroy cells thus with low-level lasers, the non-thermal therapy can promote tissue and cellular modifications through several different kinds of metabolic pathways (de Moraes Maia et al. 2011). Examples include an increased activity within the mitochondria, increasing amounts of vascularization and the synthesis of fibroblasts which can all aid in tissue healing and remodelling (de Moraes Maia et al. 2011). Wound healing comprises of a very intricate interaction between several cell types and can be divided into three phases; an inflammatory phase, a proliferative phase and a remodelling phase. Fibroblasts,

which are key players within the proliferative phase, have been extensively studied in regards to the effect of LLLT on their growth and locomotion (Chung et al. 2011; Posten et al. 2005).

The output range of low level lasers is between 1-1000mW and at a wavelength between 632 and 1064 nm a biological response is elicited. The lasers are safe to use since they do not emit heat, vibration or sound and acts by stimulation of a photochemical reaction within cells which is commonly referred to as biostimulation or photobiomodulation (Hashmi et al. 2010). When an electron within a treated chromophore absorbs photons of light the cell becomes excited and jumps from a low-energy orbit to a higher one (Sutherland 2002) which consequently stores energy which can then be used to carry out a range of cellular functions (Chung et al. 2011). Other cells such as immune cells have also been found to be greatly affected by LLLT. For example, mast cells which are very important for the motility of leukocytes have been shown to be degranulated when in contact with specific wavelengths of light which consequently results in the excretion of TNFα leading to an increased infiltration of leukocytes within tissues (el Sayed and Dyson 1996; Chung et al. 2011).

Acupuncture is a process the process of insertion and stimulation of needles into specific areas of the body aiding health regeneration (Vickers et al. 2013). This contemporary medicinal therapy is thought to have originated from China centuries ago; however, this therapy has dealt with substantial controversy over the years due to poorly defined cellular and biological mechanisms detailing how this therapy can relieve pain (Takano et al. 2013). Acupuncture therapy is one of the most common non-pharmacological analgesics used in treating a wide variety of pain syndromes from Bell's palsy to tennis elbow. One theory which explains acupuncture-mediated analgesia is the release of opioid peptides within the central nervous system (Takano et al. 2013). Most experts within the field have agreed that acupuncture stimulates the release of endogenous opiates such as β-endorphin and endomorphin which subsequently activates the μ- and δ-opioid receptors; however, studies have also looked into the role of serotonin (Lin 2008). The association of endogenous opiates and the serotoninergic descending inhibitory pathway has also been suggested to be a crucial mechanism of acupuncture analgesia (Lin 2008). During acupuncture therapy, Aβ, Aδ and C afferent fibres are all activated and when the Aβ and Aδ fibres are excited enough this results in the induction of an analgesic effect (Zhao 2008). Acupuncture "trigger points" have been found to be stimulated by heat, electrical currents, pressure and laser light as well as shock waves resulting in several methods of conducting this therapy (Ernst 2006). For this review, studies which only used the conventional acupuncture needles were considered.

Why it is important to do this review

To date there are no systematic reviews which compare the effectiveness of LLLT and acupuncture in a head-to-head comparison. This is mainly due to a lack of high quality clinical trials comparing both treatments. Due to the absence of comparative reviews examining both treatments, sub-group analyses can provide details of the effectiveness of each treatment as an intervention for temporomandibular joint disorders.

Objectives
To compare the effectiveness of low level laser therapy and acupuncture as interventions for treating pain caused by temporomandibular joint disorders.

Methods

Types of studies
Randomized, placebo-controlled clinical trials of low level laser therapy versus placebo laser and real acupuncture versus placebo (sham) acupuncture as interventions in treating temporomandibular joint disorders were included. Quasi-randomized trials were excluded from this review.

Types of participants
Adults aged equal to or over 18 years who presented with temporomandibular joint disorders according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) guidelines met the inclusion criteria. Those who were assessed by either complete clinical examinations of chronic pain levels (at least 4 times per week over a 12 week period) of the temporomandibular joint, have diagnosed myofascial pain syndromes, suffer from temporomandibular symptomatology such as pain, joint sounds or osteoarthritis or present established myofascial trigger points were also included within this review.

Types of interventions
For low level laser therapy trials, the experimental intervention was an active laser whereas for the placebo intervention a placebo laser producing no output was used as a control. For acupuncture trials, the experimental intervention was real acupuncture as opposed to placebo (sham) acupuncture as a control. The control acupuncture procedure did not involve penetration of the skin though a blunt needle was used through a foam pad to prevent patients from knowing which treatment they had received. Studies which had used a laser to provide acupuncture as a treatment were excluded.

Types of outcome measures

Primary outcomes
The primary outcome measure used was a visual analogue scale (VAS) which is a numerical scale used to measure subjective pain on the masseter muscles.

Secondary outcomes
Secondary outcomes were also pain intensity via VAS however upon palpation of other areas of the myofascial region; the lateral pole of the condyle, the pre-auricular region and the external auditive meatus.

Search methods for identification of studies
To identify studies to be included within the review, detailed search strategies were used for the following databases which had no language or date restrictions:

- MEDLINE/PUBMED Central (whole database to 20th of January 2015)
- The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library 2014, Issue 12)*
- Web of Science (whole database to 21st of January 2015)

Data collection and analysis
The author collected and analysed all the data presented within this comparative review.

Selection of studies
One review author independently assessed the abstracts of each relevant study from the searches performed. Upon completion of the abstract assessment, relevant studies were chosen and full articles were obtained for further assessment.

Data extraction and management
Raw data was extracted from each included trial into a workbook which was subsequently collated and organized prior to input into the statistical analysis software (RevMan 5.3) which was used.

Assessment of risk of bias in included studies
To assess the risk of bias of each study, the assessment tool in RevMan 5.3 was used. The areas assessed for bias were selection, performance, detection, attrition and reporting bias. To assess whether there was selection bias, adequate information regarding the method of random sequence generation and allocation of treatments to the patients had to be provided. Performance bias included the blinding of participants and personnel involved within the study. Detection bias entailed blinding of the outcome assessor and attrition bias refers to the reporting of incomplete data from the study. Finally, the reporting bias included adequate selective reporting of the data. The results from the assessment of bias is summarised in figure 1 and 2.

Measures of treatment effect
The primary outcomes measured were subjective pain intensity via a VAS on palpation of the masseter muscles. The secondary outcomes were also a measure of subjective pain intensity on palpation of the lateral poles of the condyle, pre-auricular regions and the external auditive meatus also rated on a VAS.

Dealing with missing data
Two studies (Smith 2006 and Mazzetto 2010) were not included within the analysis due to missing raw data from their studies.

Assessment of heterogeneity
By reviewing the included studies characteristics, heterogeneity was assessed. Heterogeneity was also assessed by reviewing the forest plots presented (see Figure 3-7) in particular the Tau^2 and Chi^2 values as well as the confidence interval and the I^2 statistic.

Subgroup analysis and investigation of heterogeneity
Subgroup analysis was performed for low level laser therapy studies. Heterogeneity within these studies was assessed by referring to the characteristics of the included studies as well as examining the forest plots (see Figure 1.2 - 1.4). The I^2 percentage of each meta-analysis indicates that there is a considerable degree of heterogeneity across the included studies. An indirect comparison was conducted between the interventions due to the absence of head-to-head randomized controlled trials. The difference between the summary effects within the sub-groups provides an estimate in comparing the two treatments together (LLLT and

Acupuncture). The validity of this indirect comparison relied heavily on the different sub-groups of trials being similar, on average, in all aspects which may affect the outcome. Essentially, an observational finding was conducted across the trials which are very liable to bias.

Results

Description of studies

See: Characteristics of included studies and Characteristics of excluded studies for detailed information.

Results of the search

16 potentially eligible studies were found; 10 studies (n = 211) for LLLT and 6 studies (n = 165) for acupuncture.

Included studies

For low level laser therapy, 10 randomized clinical trials (RCTs) (n=347) met the inclusion criteria (Carrasco 2008; Conti 1997; da Cunha 2008; da Silva 2012; Emshoff 2008; Kulekcioglu 2003; Madani 2014; Mazzetto 2007; Venancio 2005 and Venezian 2010). Within the 10 included studies, 8 studies assessed the effectiveness of LLLT on palpation of the masseter muscles via a Visual Analogue Scale (VAS). The remaining 2 studies (Carrasco 2008 and Mazzetto 2007) as well as da Silva 2012 also examined the effectiveness of LLLT but on different areas of the orofacial region; the lateral pole of the condyle, the pre-auricular region and the external auditive meatus which was included as a sub-group analysis. The sub-group analyses also had an outcome of subjective pain on palpation presented on a VAS.

For acupuncture therapy, six randomized clinical trials (n=165) met the inclusion criteria (Diracoglu 2012; Goddard 2002; Itoh 2012; Shen 2007 and 2009 and Tekin 2013). All six clinical trials assessed the effectiveness of acupuncture therapy versus placebo (sham) acupuncture on relieving subjective pain of the TMJ upon palpation of the masseter muscles expressed on a VAS scale. For all placebo acupuncture therapies, the skin was lightly pricked with a blunted acupuncture needle through a foam pad without penetrating the skin. Diracoglu 2012 also assessed the use of acupuncture on the pain pressure threshold (PPT) with a pressure algometer and measurements of unassisted jaw opening without pain. Itoh 2012 additionally assessed oral function by means of measuring the maximal mouth opening possible without pain.

More details of each trial can be found in the Characteristics of included studies tables.

Excluded studies

Eight studies did not meet the inclusion criteria and were excluded; details on reasons can be found in the Characteristics of excluded studies table. The two main reasons for exclusion within these eight trials were due to the inability to access the raw data for statistical analysis. Other reasons include the study design not being a randomized controlled trial.

Risk of bias in included studies
The risk of bias of each study was assessed by one author. Figure 1 and 2 displays a summary assessment and the risk of bias tables, respectively, adapted from the Characteristics of included studies.

Allocation (selection bias)
In 12 studies (Carrasco 2008; da Cunha 2008; da Silva 2012; Diracoglu 2012; Goddard 2002; Itoh 2012; Kulekcioglu 2003; Madani 2004; Shen 2007; Shen 2009; Tekin 2013; Venancio 2005) there was insufficient detail provided to justify either a 'high risk' or 'low risk' judgement. Consequently, an 'unclear risk' was allocated to each of these studies. The remaining 4 studies provided sufficient detail to warrant a low risk of bias.

Blinding (performance bias and detection bias)
All studies achieved a 'low risk' of bias in regards to the blinding of participants and personnel due to sufficient detail provided on the methods of blinding. Two studies (Kulekcioglu 2003; Venancio 2005) received a 'high risk' of bias in the blinding of the outcome assessments. Mazzetto 2007 did not provide sufficient information on the blinding of the outcome assessor to warrant a 'low risk' of bias consequently awarding this study an 'unclear risk' for the blinding of the outcome assessments.

Incomplete outcome data (attrition bias)
Shen 2007 did not provide any information regarding any drop-outs or missing outcome data suggesting there may be a 'high risk' of bias. Conversely, all other studies provided sufficient information on any missing data or drop-outs from the trials with appropriate explanations.

Effects of interventions

Low Level Laser Therapy versus Placebo Laser Therapy

<u>VAS of masseter muscles</u>

Eight studies (Conti 1997; da Cunha 2008; da Silva 2012; Emshoff 2008; Kulekcioglu 2003; Madani 2014; Venancio 2005 and Venezian 2010) (n=241) were included in this comparison whose outcome was assessed by a visual analogue scale (VAS). In favour of low level laser therapy, a statistically significant difference was found (standardized mean difference (SMD) = -0.29; 95% confidence interval (CI) -0.55 to -0.02, P = 0.03) suggesting that active laser therapy is more effective than placebo laser therapy in reducing subjective pain on palpation of the masseter muscles (Figure 3, Analysis 1.1).

Figure 1: Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

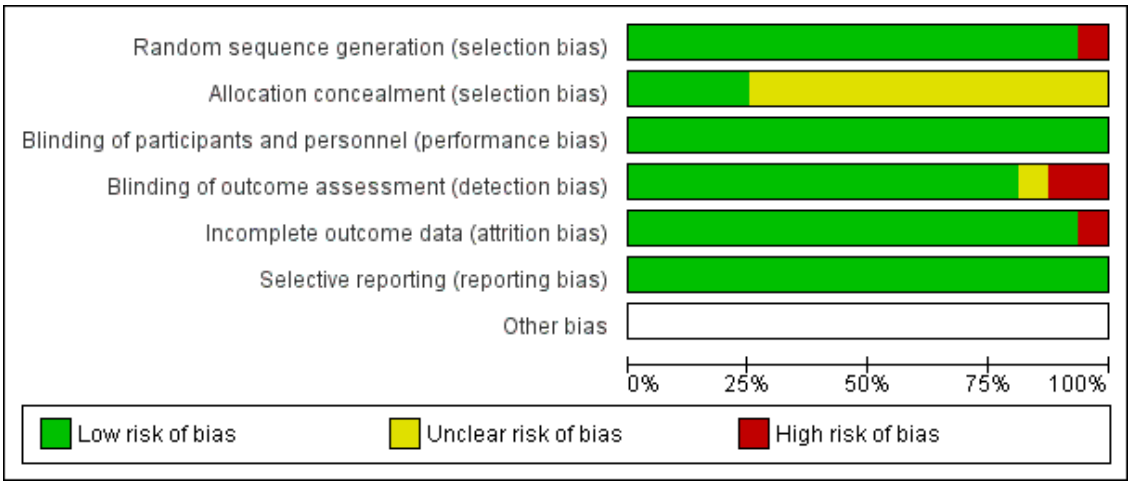

Figure 2: Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

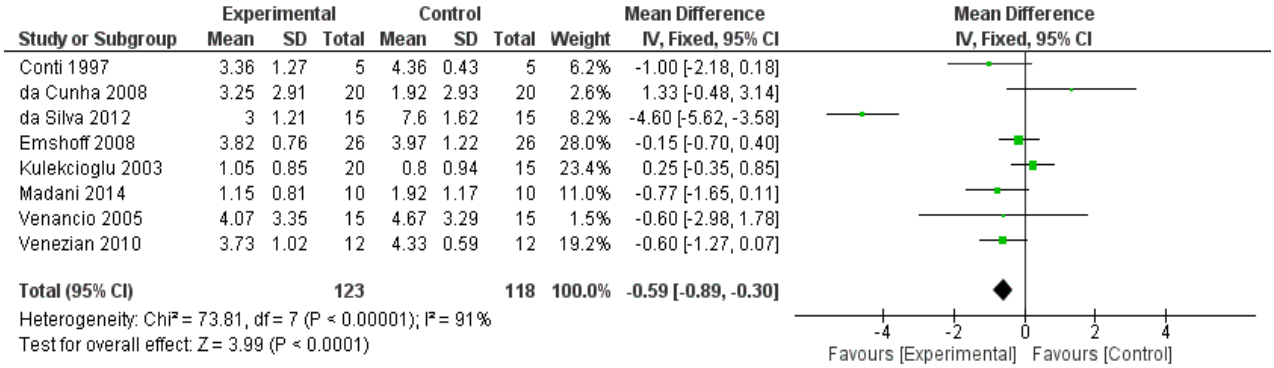

Figure 3: Low Level Laser Therapy vs Placebo Laser Treatment, outcome: Visual Analogue Scale (VAS) of the masseter muscles (Analysis 1.1).

VAS of lateral pole of the condyle

Three studies (Carrasco 2008; da Silva 2012 and Mazzetto 2007) (n = 106) assessed the subjective pain ratings via a visual analogue scale (VAS) on palpation of the lateral pole of the condyle in 106 patients. The results from the statistical analysis illustrate a significant difference in favour of low level laser therapy as opposed to placebo laser therapy. The results (standardized mean difference (SMD) = -1.02; 95% confidence interval (CI) -1.45 to -0.60, P < 0.00001) indicate a reduction in subjective pain intensity on palpation of the lateral pole of the condyle (Figure 4, Analysis 1.2).

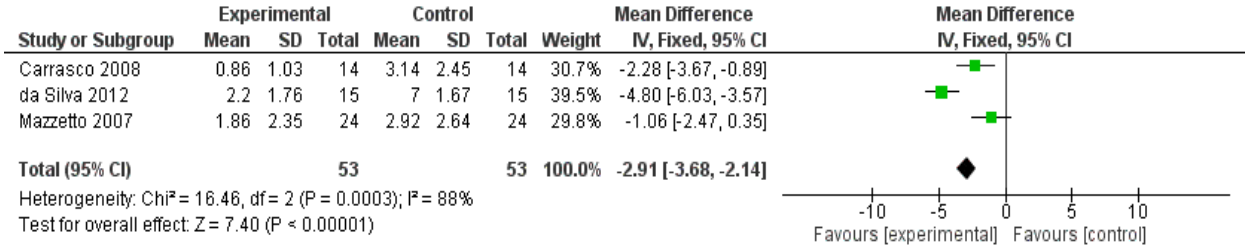

Figure 4: Low Level Laser Therapy vs Placebo Laser Treatment, outcome: Visual Analogue Scale (VAS) of the lateral pole of the condyle (Analysis 1.2).

VAS of the pre-auricular region (LLLT)

Three studies (Carrasco 2008; da Silva 2012 and Mazzetto 2007) (n = 106) were included in this comparison which assessed the outcome of subjective pain ratings via a visual analogue scale (VAS) on palpation of the pre-auricular region. A statistically significant difference was found to be in favour of low level laser therapy as opposed to placebo laser therapy with a standardized mean difference (SMD) = -1.23; 95% confidence interval (CI) -1.66 to -0.80, P < 0.00001) (Figure 5, Analysis 1.3).

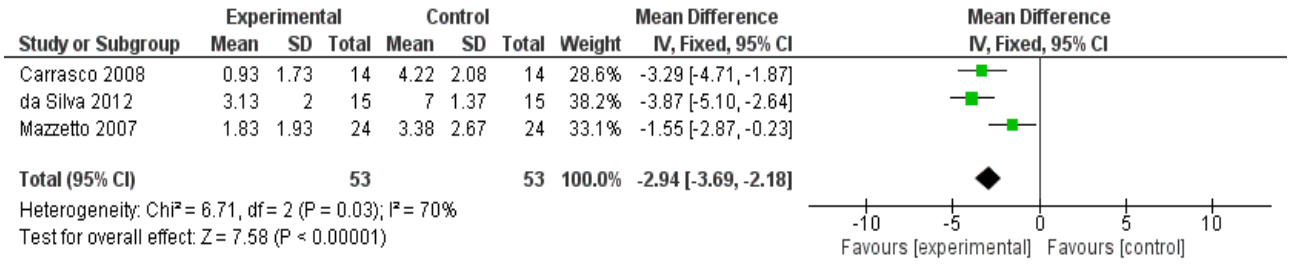

Figure 5: Low Level Laser Therapy vs Placebo Laser Treatment, outcome: Visual Analogue Scale (VAS) of the pre-auricular region (Analysis 1.3).

VAS of the external auditive meatus (LLLT)

Three studies (Carrasco 2008; da Silva 2012 and Mazzetto 2007) (n = 106) also assessed the subjective pain ratings expressed using a visual analogue scale (VAS) on palpation of the external auditive meatus after active laser and placebo laser therapy. The results from the statistical analysis (standardized mean difference (SMD) = -1.21; 95% confidence interval (CI) -1.66 to -0.76, P < 0.00001) indicate a statistically significant difference in favour of real laser therapy as opposed to placebo laser therapy (Figure 6, Analysis 1.4).

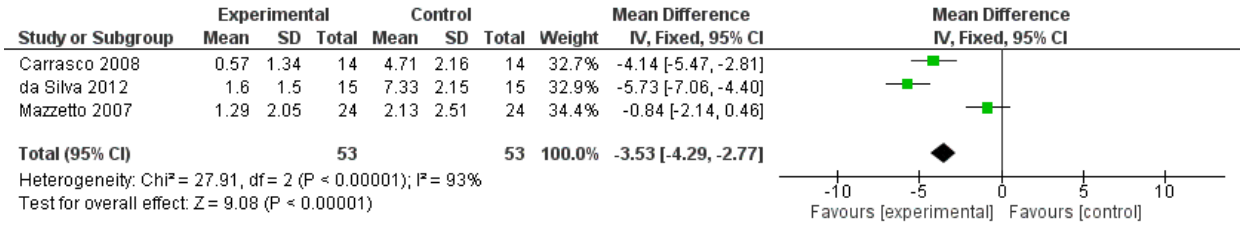

Figure 6: 1 Low Level Laser Therapy vs Placebo Laser Treatment, outcome: Visual Analogue Scale (VAS) of the external auditive meatus (Analysis 1.4).

Real Acupuncture versus Placebo (Sham) Acupuncture

VAS on palpation of masseter muscles

Six studies (Diracoglu 2012; Goddard 2002; Itoh 2012; Shen 2007; Shen 2009 and Tekin 2013) (n = 165) assessed the effectiveness of real acupuncture versus placebo (sham) acupuncture in relieving subjective pain intensity rated via a visual analogue scale (VAS). The results from the statistical analysis did not present any statistically significant results in favour of the real acupuncture treatment. The results (standardized mean difference (SMD) = -0.14; 95% confidence interval (CI) -0.78 to 0.50, P = 0.67) (Figure 7, Analysis 2.1) indicate that the p-value is far greater than 0.05 thus the null hypothesis (no difference between the treatments) is accepted. This suggests that real acupuncture therapy is indeed no more effective than placebo acupuncture in relieving subjective pain on palpation of the masseter muscles.

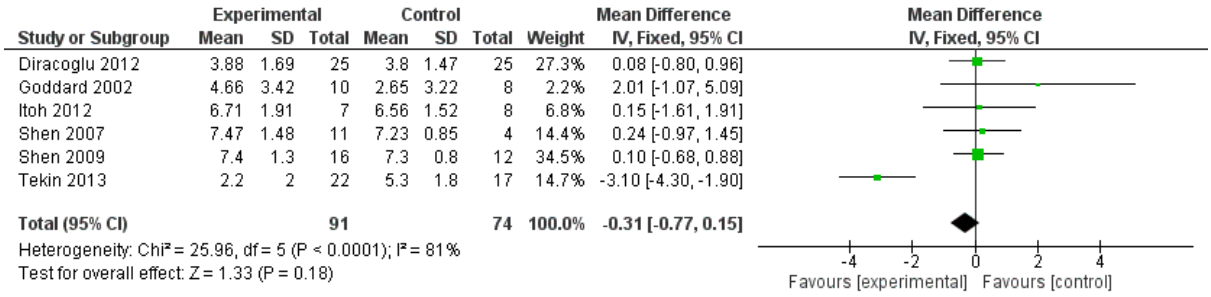

Figure 7: Forest plot of comparison: 2 Real Acupuncture vs Sham Acupuncture Treatment, outcome: Visual Analogue Scale (VAS) on palpation (Analysis 2.1).

Discussion

Summary of main results

The results from the sub-group analysis of LLLT versus PLT showed a statistically significant difference in favour of active laser therapy. Four sub-group analyses were performed which assessed the outcome of subjective pain intensity rated on a visual analogue scale on palpation of the following areas of the orofacial region; the masseter muscles, the lateral pole of the condyle, the pre-auricular region and the external auditive meatus. The results from the first sub-group analysis included eight studies which assessed the effectiveness of low level laser therapy versus placebo laser therapy in treating temporomandibular joint disorders. The results (analysis 1.1) show that there is a statistically significant difference in favour of active laser therapy ($P = 0.03$).

The following three comparisons (analysis 1.2, 1.3 and 1.4) only included three studies (Carrasco 2008; da Silva 2012 and Mazzetto 2007) (n=106) which all assessed the effectiveness of low level laser therapy versus a laser with no output (placebo) on subjective pain intensity. The location which the laser was applied varied from Analysis 1.1 thus a separate comparison had to be performed. The results from analysis 1.2 also revealed that there is a statistically significant difference in favour of active laser therapy ($P < 0.00001$). Analysis 1.3 and 1.4 also demonstrated a statistically significant difference in favour of active laser therapy ($P < 0.00001$ for both analyses) as opposed to placebo laser therapy.

Acupuncture therapy versus placebo (sham) therapy was investigated by six clinical trials included in this review (Diracoglu 2002; Goddard 2002; Itoh 2012; Shen 2007; Shen 2009 and Tekin 2013) (n=165) on the subjective pain intensity ratings via a visual analogue scale. The results from the statistical analysis ($P=0.67$) of these six trials indicate that there is no statistically significant difference between placebo acupuncture and real acupuncture therapy in relieving subjective pain. Comparing both treatments as therapies for treating temporomandibular joint disorder, the results from this review indicate that LLLT is statistically more effective than acupuncture therapy for temporomandibular joint disorders.

Within this review, two treatments were assessed for their respective effectiveness in treating temporomandibular joint disorders. LLLT was compared against

acupuncture therapy in treating this disorder by reviewing the overall statistical significance of the effectiveness of each treatment method. Since no head-to-head comparisons had been performed to-date, a sub-group analysis had to be performed to indicate the effectiveness of each treatment. Indirect comparison of each treatment was conducted due to the absence of head-to-head comparisons. Trials of LLLT vs. PLT were contrasted with real acupuncture versus sham acupuncture therapy in an indirect comparison. Patients from LLLT versus PLT were not directly compared to patients from acupuncture versus placebo as this comparison ignores the potential benefits of randomization and suffers from bias.

Overall completeness and applicability of evidence

There is a need for more high-quality randomized controlled trials which assess low level laser therapy and acupuncture against each other so that an indirect comparison does not need to be performed. The trials used within this review have a relatively low number of patients in each thus more RCTs which can assess a larger population will provide more concrete evidence on the effectiveness of these treatments for temporomandibular disorders. The evidence from the statistical analyses of low level laser therapy shows a lot of potential as a non-invasive treatment for temporomandibular disorders. On the other hand, given the statistical insignificance of the results assessing acupuncture as a therapy, more research needs to be conducted in assessing the true effectiveness of this therapy.

Quality of the evidence

Randomized controlled trials which assessed either low level laser therapy versus placebo or acupuncture therapy versus placebo acupuncture were included within the review. The statistical analyses conducted within the review provide high-quality evidence on the effectiveness of both therapies in comparison to placebo treatments.

Potential biases in the review process

As only one author independently gathered, analysed and presented the results for this review there are several areas where there may have been a potential for bias. Having more than one author assess the risk of bias of each individual study would greatly decrease the risk of bias. In addition, if the methodology of the trials included within the review were standardized, the results obtained from the experiments would remove any risk of bias. Suggestions include; blinding of all participants and assessors involved in the study as well as clearly stated randomization techniques in allocating patients to certain treatment groups.

Agreements and disagreements with other studies or reviews

In the last decade, there have been several reviews (Petrucci et al. 2011; Melis et al. 2012; de Moraes Maia et al. 2012) which have assessed the effectiveness of low level laser therapy versus placebo laser therapy in treating temporomandibular disorders. The results from these reviews indicate that there was no evidence at the time to indicate that low level laser therapy is indeed effective in treating temporomandibular disorders. While this may have been the case due to the heterogeneity of the standardization of the laser protocols, more clinical trials which have less heterogeneity across studies may lead to more definitive results. For acupuncture therapy, to-date there is one systematic review (La Touche et al. 2010) of randomized controlled trials which concluded that acupuncture therapy is a reasonable adjunctive therapy in relieving pain in patients with temporomandibular

disorders. The conclusions from this review reiterate results from La Touche et al. 2010 suggesting the need for more high-quality, high sample number, randomized controlled trials which assess the effectiveness of acupuncture therapy as an intervention for temporomandibular joint disorder patients.

Authors' conclusions

Implications for practice

The result from this review provides evidence that low level laser therapy is effective in minimising subjective pain intensity in patients with temporomandibular joint disorders. Clinicians can use this information to aid in formulating an effective treatment regime for patients who are looking for non-invasive methods in treating their TMD. On the other hand, due to a limited amount of high-quality trials examining acupuncture therapy as a treatment for TMD, it is difficult to decide whether this treatment is effective. However, there is some evidence (Diracoglu 2012; Goddard 2002; Itoh 2012; Shen 2007; Shen 2009) that acupuncture has reduced pain levels in patients with TMD. In the end, the individual clinician's judgement determines whether or not to use this therapy.

Implications for research

More research is needed in assessing both low level laser therapy and acupuncture therapy since this review only included a small number of clinical studies. The more studies which are conducted to assess the effectiveness of both low level laser therapy and acupuncture will provide more concrete evidence to the true effect of these therapies. Since there have been no head-to-head comparisons of low level laser therapy versus acupuncture therapy, this is an important research area as the capabilities and potential of these therapies has not yet been fully exploited.

Acknowledgements

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Characteristics of studies

Characteristics of included studies

Table 1: Characteristics of *Carrasco 2008* and assessment of the risk of bias.

Methods	The study was performed using a random, placebo-controlled and double-blind research design.	
Participants	14 patients presenting temporomandibular disorder symptoms were selected for this study.	
Interventions	Active Low Intensity Laser Therapy (LILT) vs. Placebo Laser	
Outcomes	Subjective pain levels using the Visual Analogue Scale (VAS) immediately after direct manual palpation of the condyle lateral pole in the pre-aurical region, and of the external auditive duct.	
Notes	Laser device used was the GaAlAs Twin Laser (MM Optics, Sao Carlos - SP, Brazil), which operates with a continuous laser beam (780 nm wavelength; 70 mW power output).	
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Patients were randomly divided into two groups; however, method of random sequence generation was not stated.
Allocation concealment (selection bias)	Unclear risk	Insufficient information provided on the method of concealment to permit the judgement of either 'Low Risk' or 'High Risk'
Blinding of participants and personnel (performance bias)	Low risk	Two identical probes supplied by the manufacturer were used and were marked with different letters (A and B) by a clinician who did not perform the applications.
Blinding of outcome assessment (detection bias)	Low risk	Throughout the whole procedure neither the clinician nor the patients were aware whether the laser probe in use was active or inactive however, probes were identified at the end of the applications and evaluations.
Incomplete outcome data (attrition bias)	Low risk	No missing outcome data reported
Selective reporting (reporting bias)	Low risk	All pre-specified outcomes of interest within this study were evaluated and reported within the study.

Table 2: Characteristics of *Conti 1997* and assessment of the risk of bias.

Methods	The study was performed using a randomized, double-blind and placebo-controlled design	
Participants	20 subjects (18 females and 2 males) with Temporomandibular Joint Disorder	
Interventions	Group 1 (n=5): Myogenous pain patients receiving real Low Level Laser Therapy Group 2 (n=5): Arthrogenous pain patients receiving real Low Level Laser Therapy Group 3 (n=5): Myogenous pain patients receiving placebo Low Level Laser Therapy Group 4 (n=5): Arthrogenous pain patients receiving placebo Low Level Laser Therapy	
Outcomes	Visual Analogue Scale (VAS) to assess individual levels of pain, total vertical opening (TVO), right lateral excursion (LATRIG), left lateral excursion (LATLEF) and protrusive excursion (PROT) measured using a plastic millimetre ruler.	
Notes	Laser device used was a GaAlAs laser device with an energy output of 4 joules (OMNILASE, LASERDYNE PTY Ltd.)	
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Each patient was randomly assigned to either the experimental or control group, however, the method of random sequence generation was not detailed
Allocation concealment (selection bias)	Low risk	The laser device used was always handled by a research assistant to ensure the double-blind design.
Blinding of participants and personnel (performance bias)	Low risk	Quote: "Neither the patients nor the examiner was able to differentiate between real or placebo treatment."
Blinding of outcome assessment (detection bias)	Low risk	No details provided on blinding of outcome assessment, however, the outcome measurement is not likely to be influenced by the lack of blinding.
Incomplete outcome data (attrition bias)	Low risk	No drop-outs reported
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 3: Characteristics of *da Cunha 2008* and assessment of the risk of bias.

Methods	The study design was a random, placebo-controlled research trial	
Participants	40 patients (39 female and 1 male) with orofacial pain associated with TMD were randomly divided into either experimental group or control group	
Interventions	Group 1 (n=20): laser treatment with a Ga-La-As low level laser Group 2 (n=20): placebo laser treatment	
Outcomes	Visual Analogue Scale (VAS) and Craniomandibular Index (CMI)	
Notes	The laser device used was a GaAlAs low level laser (830 nm wavelength and an output of 500 mW) from Biolux laser - Bio-Art, Sao Carlos, SP, Brazil.	
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Patients were randomly assigned to either experimental or control group, however, no information was provided on the method of randomization
Allocation concealment (selection bias)	Unclear risk	Insufficient information provided on the method of concealment to permit the judgement of either 'Low Risk' or 'High Risk'
Blinding of participants and personnel (performance bias)	Low risk	The patients were not aware whether they were allocated to either the experimental or control group.
Blinding of outcome assessment (detection bias)	Low risk	The professional responsible for evaluation of outcomes was not aware of the group to which each patient belonged.
Incomplete outcome data (attrition bias)	Low risk	No missing outcome data reported
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 4: Characteristics of *da Silva 2012* and assessment of the risk of bias.

Methods	The study was a randomized, placebo-controlled double-blind design	
Participants	45 (30 women and 15 male aged 25-53 years) subjects with intra-articular temporomandibular disorder (IA-TMD)	
Interventions	Group 1 (n=15): energy dose of 52.5J/cm2 Group 2 (n=15): energy dose of 105.0J/cm2 Group 3 (n=15): placebo group (0J/cm2)	
Outcomes	Maximum pain-free mouth opening using a pachymeter and symptoms on palpation of the left edge of the condyle, in the pre-auricular region, in the external auditory meatus and on the masseter and anterior temporalis muscles were assessed using a Visual Analogue Scale (VAS).	
Notes	The laser device used was a low intensity infrared laser (Laser Twin Set MM Optics Ltd, Sao Carlos, Sao Paulo, with a 780 nm wavelength and 70 mW output).	
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Patients were randomly divided into the three treatment groups, however, details were not provided on the method of randomization.
Allocation concealment (selection bias)	Unclear risk	Insufficient information provided on the method of concealment to permit the judgement of either 'Low Risk' or 'High Risk'
Blinding of participants and personnel (performance bias)	Low risk	Both the patients and investigator were unaware which group they were assigned to.
Blinding of outcome assessment (detection bias)	Low risk	The outcome assessor was not aware which group the patient was assigned.
Incomplete outcome data (attrition bias)	Low risk	No drop-outs reported
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 5: Characteristics of *Diracoglu 2012* and assessment of the risk of bias.

Methods	The study was a double-blind, randomized, placebo-controlled study	
Participants	52 subjects (45 females and 7 males aged 18-57 years) with established myofascial trigger points	
Interventions	Group 1 (study group, n=26): dry needling therapy Group 2 (placebo group, n=26): sham dry needling	
Outcomes	Pain Pressure Threshold (PPT), pain intensity using a Visual Analogue Scale (VAS) and unassisted jaw opening measurement	
Notes		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Patients with myofascial trigger points were randomised into one of two groups by using randomized numbers obtained from QuickCalcs software.
Allocation concealment (selection bias)	Unclear risk	Insufficient information provided on the method of concealment to permit the judgement of either 'Low Risk' or 'High Risk'.
Blinding of participants and personnel (performance bias)	Low risk	Patients were unaware as to which treatment group they had been allocated.
Blinding of outcome assessment (detection bias)	Low risk	Assessments were carried out by a physician who was blinded to the patients' groups.
Incomplete outcome data (attrition bias)	Low risk	1 drop out from study group; reason: "Difficulty in coming to clinic to treatment" and 1 drop out from placebo group; reason: "Did not benefit from the treatment".
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 6: Characteristics of *Emshoff 2008* and assessment of the risk of bias.

Methods	The study was a randomized, double-blind, placebo-controlled trial	
Participants	52 subjects with temporomandibular joint pain (ages 18-58, mean: 42.9 years)	
Interventions	Group 1 (n=26): *Active* Low Level Laser Therapy Group 2 (n=26): *Sham* Low Level Laser Therapy	
Outcomes	Patient self-assessment using a Visual Analogue Scale (VAS)	
Notes	The laser device used was a red-beam laser (Model 2000; Helbo Medizintechnik, Austria) with 632.8 nm HeNe laser and 30 mW output power	
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	The patients were randomly assigned to either the active laser group or the placebo laser group, however, no details were provided on the method of randomization.
Allocation concealment (selection bias)	Low risk	Quote: " Participants were randomly assigned to either the active (26 patients) or sham laser group (26 patients) by one of the non-treating authors."
Blinding of participants and personnel (performance bias)	Low risk	Patients and investigators were both blinded to the treatments which the patients received.
Blinding of outcome assessment (detection bias)	Low risk	Outcome assessors were unaware of which treatment the subjects had received.
Incomplete outcome data (attrition bias)	Low risk	Group 1 drop-out (n=3) and Group 2 drop-out (n=2).
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 7: Characteristics of *Goddard 2002* and assessment of the risk of bias.

Methods	The study was a randomized, double-blind and placebo-controlled trial	
Participants	18 patients (15 females and 3 males, aged 22-52 years) with myofascial pain of the jaw muscles.	
Interventions	Group 1 (n=10): Acupuncture therapy Group 2 (n=8): Placebo (sham) acupuncture therapy	
Outcomes	Quote: “A Visual Analogue Scale (VAS) was used to measure changes in masseter muscle pain evoked by mechanical stimulation of the masseter muscle before and after the experiment.”	
Notes		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Subjects were randomly assigned to one of two groups by use of a random table number generator.
Allocation concealment (selection bias)	Unclear risk	Insufficient information provided on the method of concealment to permit the judgement of either 'Low Risk' or 'High Risk'.
Blinding of participants and personnel (performance bias)	Low risk	Subjects were unaware of which treatment group they had been assigned to.
Blinding of outcome assessment (detection bias)	Low risk	The investigator who performed the assessment was also blinded to the subject's group assignment.
Incomplete outcome data (attrition bias)	Low risk	No drop-outs reported.
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 8: Characteristics of *Itoh 2012* and assessment of the risk of bias.

Methods	The study employed a single-blind, randomized and placebo-controlled trial	
Participants	16 patients (five women and 11 men, ages 19-24) with TMD	
Interventions	Group 1 (n=7): Trigger point acupuncture Group 2 (n=8): Sham acupuncture	
Outcomes	Pain intensity (Visual analogue scale) and oral function (maximal mouth opening)	
Notes		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	The patients were randomly assigned to either group with the use of computerized randomisation program.
Allocation concealment (selection bias)	Unclear risk	Insufficient information provided on the method of concealment to permit the judgement of either 'Low Risk' or 'High Risk'.
Blinding of participants and personnel (performance bias)	Low risk	Quote: "Patients were blinded to their treatment assignment."
Blinding of outcome assessment (detection bias)	Low risk	Quote: "The measurements were performed by an independent investigator who was not informed about the treatment sequence or the treatment the patient received before each measurement."
Incomplete outcome data (attrition bias)	Low risk	1 reported drop-out from the trigger point acupuncture group
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 9: Characteristics of *Kulekcioglu 2003* and assessment of the risk of bias.

Methods	Randomized, placebo-controlled trial	
Participants	35 patients (28 females and 7 males aged 20-59 years) with orofacial pain, TMJ sounds, limited mouth opening or TMJ locking.	
Interventions	Group 1 (n=20): Active laser treatment Group 2 (n=15): Placebo laser treatment	
Outcomes	Pain intensity via Visual Analogue Scale (VAS), number of tender points and joint sounds, maximal active and passive mouth opening and right and left lateral jaw motion.	
Notes		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	The patients were randomly assigned to one of the two groups, however, no details were provided on the method of randomization.
Allocation concealment (selection bias)	Unclear risk	Insufficient information provided on the method of concealment to permit the judgement of either 'Low Risk' or 'High Risk'.
Blinding of participants and personnel (performance bias)	Low risk	Quote: "All patients were evaluated by the first investigator who was blinded to treatment groups."
Blinding of outcome assessment (detection bias)	High risk	Blinding of assessor was not reported within the study.
Incomplete outcome data (attrition bias)	Low risk	No drop-outs reported
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 10: Characteristics of *Madani 2014* and assessment of the risk of bias.

Methods	The study design was a double-blind, randomized placebo-controlled trial	
Participants	20 patients with Temporomandibular Joint osteoarthritis	
Interventions	Group 1 (n=10): Low Level Laser Therapy Group 2 (n=10): Placebo laser stimulation	
Outcomes	Maximum mouth opening measured with a millimetre ruler, presence or absence of joint sounds and VAS scale used to quantify pain at palpation.	
Notes	The laser device used was a low-level laser emitting a pulsed infrared beam of 810 nm wavelength (Mustang 2000+, Moscow, Russia).	
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Patients were randomly assigned to either the treatment or placebo group, however, no information was provided on the method of randomization.
Allocation concealment (selection bias)	Unclear risk	Insufficient information was provided on the method of concealment to permit the judgement of either 'Low Risk' or 'High Risk'.
Blinding of participants and personnel (performance bias)	Low risk	Both the patients and investigators were unaware of which treatment was being given.
Blinding of outcome assessment (detection bias)	Low risk	Quote: "All evaluations were conducted by a blinded investigator who was not included in the study protocol and who had been instructed by a prosthodontist before starting the project, to achieve reliable pain measurements."
Incomplete outcome data (attrition bias)	Low risk	No drop-outs reported
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 11: Characteristics of *Mazzetto 2007* and assessment of risk of bias.

Methods	The study was a randomized, double-blind and placebo-controlled study	
Participants	48 patients with temporomandibular disorder symptomatology	
Interventions	Group 1 (n=24): Experimental Low Intensity Laser Therapy Group 2 (n=24): Placebo laser treatment without radiation emission but containing a sonorous mechanism for application time	
Outcomes	Quote: “Level of pain using the Visual Analogue Scale (VAS) after direct palpation of the lateral pole of the condyle, pre-articular region, and external auditive duct on the most painful side before treatment.”	
Notes	The laser device used within this study was a GaAlAs laser TWIN LASER (MM Optics, Sao Carlos - SP, Brazil) that operates with a continuous laser beam (780 nm wavelength; 50 60 and 70 mW power output).	
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Patients were randomly allocated to either active or placebo laser groups, however, details on the method of randomization were not provided.
Allocation concealment (selection bias)	Low risk	Two identical probes supplied by the manufacturer were used and each was marked with either letter A or B by a clinician who did not perform the applications.
Blinding of participants and personnel (performance bias)	Low risk	Quote: "During the entire study neither the clinician nor the subjects knew which one was the active probe."
Blinding of outcome assessment (detection bias)	Unclear risk	All procedures had been performed by the same investigator.
Incomplete outcome data (attrition bias)	Low risk	No drop-outs reported
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 12: Characteristics of *Shen 2007* and assessment of the risk of bias.

Methods	The study employed a single-blind, randomized and placebo-controlled clinical design.	
Participants	15 chronic myofascial pain adult subjects.	
Interventions	Group 1 (n=9): Real acupuncture therapy Group 2 (n=6): Placebo (sham) acupuncture therapy	
Outcomes	General pain on a numeric rating scale and pain on a Visual Analogue Scale (VAS) from a mechanical pain stimulus applied with an algometer.	
Notes		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	Treatment was randomly assigned to the study subject based on the order of involvement.
Allocation concealment (selection bias)	Unclear risk	Insufficient information was provided on the method of concealment to permit the judgement of either 'Low Risk' or 'High Risk'.
Blinding of participants and personnel (performance bias)	Low risk	Acupuncturist was not blinded due to the involvement of acupuncture in the study; however, subjects were blinded to which treatment they received.
Blinding of outcome assessment (detection bias)	Low risk	An independent assessor collected the data from the study subjects.
Incomplete outcome data (attrition bias)	High risk	20 patients initially recruited, however, only 15 patients qualified of which all completed the study.
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 13: Characteristics of *Shen 2009* and assessment of the risk of bias.

Methods	The study was a randomised controlled trial	
Participants	28 subjects over the age of 18 with chronic myofascial pain of the jaw muscles	
Interventions	Group 1 (n= 16): Real acupuncture Group 2 (n=12): Placebo (sham) acupuncture	
Outcomes	Head and neck pain ratings on a numerical rating scale and a mechanical pain stimulus on the masseter muscle rated on a visual analogue scale (VAS).	
Notes		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "A list of 50 random numbers was generated by computer and subjects were assigned a number subsequently by enrolment."
Allocation concealment (selection bias)	Unclear risk	Insufficient information was provided on the method of concealment to permit the judgement of either 'Low Risk' or 'High Risk'.
Blinding of participants and personnel (performance bias)	Low risk	To ensure the blinding of patients and investigator the needles were inserted through an Ace weather strip foam pad.
Blinding of outcome assessment (detection bias)	Low risk	The outcome assessor was blinded to which treatment group each patient belonged.
Incomplete outcome data (attrition bias)	Low risk	31 patients were asked to participate however, 3 subjects withdrew prior to the start of the study due to needle phobia, claustrophobia and lack of posterior teeth for clenching.
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 14: Characteristics of *Tekin 2013* and assessment of the risk of bias.

Methods	The study was a randomized, double-blind, placebo-controlled trial	
Participants	39 patients (aged 24-65 years) with myofascial pain syndrome	
Interventions	Group 1 (n=22): Dry needling Group 2 (n=17): Sham dry needling	
Outcomes	Pain was evaluated with a Visual Analogue Scale (VAS) and Quality of Life (QoL) was evaluated using the Turkish version of Short Form SF-36.	
Notes		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomization was performed using random numbers obtained from QuickCalcs software.
Allocation concealment (selection bias)	Unclear risk	Insufficient information was provided on the method of concealment to permit the judgement of either 'Low Risk' or 'High Risk'.
Blinding of participants and personnel (performance bias)	Low risk	Both the patient and the physician were blinded from the treatment.
Blinding of outcome assessment (detection bias)	Low risk	Quote: "... the evaluations were carried out by another physician who was blinded to the patients' groups."
Incomplete outcome data (attrition bias)	Low risk	0 patients were excluded from the analysis of results.
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 15: Characteristics of *Venancio 2005* and assessment of the risk of bias.

Methods	The study was a randomized, double-blind research trial	
Participants	30 patients (25 female and 5 male) presenting with temporomandibular joint (TMJ) pain and mandibular dysfunction.	
Interventions	Group 1 (n=15): Active Low-Intensity Laser Therapy Group 2 (n=15): Placebo laser therapy	
Outcomes	Subjective pain reporting with a Visual Analogue Scale (VAS), pressure pain threshold of TMJ (PPT) and mandibular dysfunction by painless maximal vertical opening (MVO).	
Notes	The laser device used within this study was a 780nm Ga-Al-As (Gallium-Aluminium-Arsenide) diode laser (Twin Laser) with an output of 30mW	
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	The patients were randomly assigned to either the experimental or placebo group, however, the method of randomization was not detailed.
Allocation concealment (selection bias)	Unclear risk	Insufficient information was provided on the method of concealment to permit the judgement of either 'Low Risk' or 'High Risk'.
Blinding of participants and personnel (performance bias)	Low risk	Both the participants and investigator were unaware of which treatment group each patient belonged to.
Blinding of outcome assessment (detection bias)	High risk	No information provided on the blinding of the outcome investigator.
Incomplete outcome data (attrition bias)	Low risk	No drop outs reported
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Table 16: Characteristics of *Venezian 2010* and assessment of the risk of bias.

Methods	The study was a double-blind, randomized, placebo-controlled study.
Participants	48 patients (five men and 43 women) with myofascial pain syndrome
Interventions	Group 1 (n=12): 25 J/cm2 (actual) Group 2 (n=12): 25 J/cm2 (placebo) Group 3 (n=12): 60 J/cm2 (actual) Group 4 (n=12): 60 J/cm2 (placebo)
Outcomes	Visual Analogue Scale (VAS) for pain to palpation on the right and left masseter muscle and right and left anterior temporalis. Electromyographic (EMG) activity of the masseter and anterior temporalis muscles.
Notes	The laser device used was a GaAlAs Low Level Laser (780 nm - infrared) from Twin Laser, MM Optics LTDA, Sao Carlos, Brazil.

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "The patients were randomly assigned into four groups, using a computer program."
Allocation concealment (selection bias)	Low risk	Quote: "The laser had two identical application points, one active and one placebo (which emitted no energy), but both had a sound device and a guide light. The points were named A and B by a researcher who did not participate in the treatment and evaluations."
Blinding of participants and personnel (performance bias)	Low risk	Patients were all blinded to the treatments they received.
Blinding of outcome assessment (detection bias)	Low risk	An investigator who was blinded to the treatment which each patient received performed all the outcome assessments.
Incomplete outcome data (attrition bias)	Low risk	No incomplete data was detailed within the report.
Selective reporting (reporting bias)	Low risk	All pre-specified outcome measure within this study were evaluated and reported with the study.

Characteristics of excluded studies

Cetiner 2006

Reason for exclusion	Not a randomized controlled trial

Chou 2009

Reason for exclusion	Treatment for upper trapezius muscles

de Godoy 2013

Reason for exclusion	Research paper is a study protocol

Fernandez-Carnero 2010

Reason for exclusion	Outcome measures not similar

Ficockova 2007

Reason for exclusion	Not a randomized controlled trial

Katsoulis 2010

Reason for exclusion	Laser acupuncture was used as an intervention

Mazzetto 2010

Reason for exclusion	No raw data available for analysis

Shirani 2009

Reason for exclusion	Test subjects included non-adults

Smith 2006

Reason for exclusion	No raw data available for analysis

References to studies

Included studies

Carrasco 2008

Carrasco TG, Mazzetto MO, Mazzetto RG, Mestriner W. Low Intensity Laser Therapy in Temporomandibular Disorder: a Phase II Double-Blind Study. *Journal of Craniomandibular Practice* 2008; 26(4):274-281.

Conti 1997

Conti PCR. Low Level Laser Therapy in the Treatment of Temporomandibular Disorders (TMD): A Double-Blind Pilot Study. *The Journal of Craniomandibular Practice* 1996; 15(2):144-149.

da Cunha 2008

da Cunha LA, Firoozmand LM, da Silva AP, Esteves SA, de Oliveira W. Efficacy of low-level laser therapy in the treatment of temporomandibular disorders. *International Dental Journal* 2008; 58:213-217.

da Silva 2012

da Silva MAM, Botelho AL, Turim CV, da Silva AMBR. Low Level Laser Therapy as an Adjunctive Technique in the Management of Temporomandibular Disorders. *The Journal of Craniomandibular Practice* 2012; 30(4):264-271.

Diracoglu 2012

Diracoglu D, Vural M, Karan A, Aksoy C. Effectiveness of dry needling for the treatment of temporomandibular myofascial pain: A double-blind, randomized, placebo-controlled study. *Journal of Back and Musculoskeletal Rehabilitation* 2012; 25(4):285-290.

Emshoff 2008

Emshoff R, Bosch R, Pumpel E, Schoning H, Strobl H. Low-level laser therapy for treatment of temporomandibular joint pain: a double-blind and placebo-controlled trial. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology* 2008; 105(4):452-456.

Goddard 2002

Goddard G, Karibe H, McNeill C, Villafuerte E. Acupuncture and Sham Acupuncture Reduce Muscle Pain in Myofascial Pain Patients. *Journal of Orofacial Pain* 2002; 16(1):71-76.

Itoh 2012

Itoh K, Asai S, Ohyabu H, Imai K, Kitakoji H. Effects of Trigger Point Acupuncture Treatment on Temporomandibular Disorders: A Preliminary Randomized Clinical Trial. *Journal of Acupuncture and Meridian Studies* 2012; 5(2):57-62.

Kulekcioglu 2003

Kulekcioglu S, Sivrioglu K, Ozcan O, Parlak M. Effectiveness of low-level laser therapy in temporomandibular disorder. *Scandinavian Journal of Rheumatology* 2003; 32(2):114-118.

Madani 2014

Madani AS, Ahrari F, Nasiri F, Abtahi M, Tuner J. Low-level laser therapy for management of TMJ osteoarthritis. *The Journal of Craniomandibular & Sleep Practice* 2014; 32(1):38-44.

Mazzetto 2007

Mazzetto MO, Carrasco TG, Bidinelo RF, de Andrade Pizzo RC, Mazzetto RG. Low Intensity Laser Application in Temporomandibular Disorders: A Phase I Double-Blind Study. *The Journal of Craniomandibular Practice* 2006; 25(3):186-192.

Shen 2007

Shen YF, Goddard G. The Short-Term Effects of Acupuncture on Myofascial Pain Patients after Clenching. Pain Practice: *The Official Journal of World Institute of Pain* 2007;7(3):256-264.

Shen 2009

Shen YF, Younger J, Goddard G, Mackey S. Randomized Clinical Trial of Acupuncture for Myofascial Pain of the Jaw Muscles. *Journal of Orofacial Pain* 2010; 23(4):353-359.

Tekin 2013

Tekin L, Akarsu S, Durmus O, Cakar E, Dincer U, Kiralp MZ. The effect of dry-needling in the treatment of myofascial pain syndrome: a randomized double-blinded placebo-controlled trial. *Clinical Rheumatology* 2012; 32:309-315.

Venancio 2005

Venancio RDA, Camparis CM, De Fatima Zanirato R. Low intensity laser therapy in the treatment of temporomandibular disorders: a double-blind study. *Journal of Oral Rehabilitation* 2005; 32:800-807.

Venezian 2010

Venezian GC, da Silva R, Mazzetto RG, Mazzetto MO. Low Level Laser Effects on Pain to Palpation and Electromyographic Activity in TMD Patients: A Double-blind, Randomized, Placebo-Controlled Study. *The Journal of Craniomandibular Practice* 2009;28(2):84-91.

Excluded studies

Cetiner 2006

Cetiner S, Kahraman SA, Yucetas S. Evaluation of low-level laser therapy in the treatment of temporomandibular disorders. *Photomedicine and Laser Surgery* 2006; 24(5): 637-641.

Chou 2009

Chou LW, Hsieh YL, Kao MJ, Hong CZ. Remote influences of acupuncture on the pain intensity and the amplitude changes of endplate noise in the myofascial trigger point of the upper trapezius muscle. *Archives of Physical Medicine and Rehabilitation* 2009; 90(6): 905-912.

de Godoy 2013

de Godoy CH, Silva PF, de Araujo DS, Motta LJ, Biasotto-Gonzalez DA, Politti F, Mesquita-Ferrari RA, Fernandes KP, Albertini R, Bussadori SK. Evaluation of effect of low-level laser therapy on adolescents with temporomandibular disorder: study protocol for a randomized controlled trial. *Trials* 2013; 14: 229-235.

Fernandez-Carnero 2010

Fernández-Carnero J, La Touche R, Ortega-Santiago R, Galan-del-Rio F, Pesquera J, Ge HY, Fernández-de-Las-Peñas C. Short-term effects of dry needling of active myofascial trigger points in the masseter muscle in patients with temporomandibular disorders. *Journal of Orofacial Pain* 2010; 24(1): 106-112.

Ficockova 2007

Fikácková H, Dostálová T, Navrátil L, Klaschka J. Effectiveness of low-level laser therapy in temporomandibular joint disorders: a placebo-controlled study. *Photomedicine and Laser Surgery* 2007; 25(4): 297-303.

Katsoulis 2010

Katsoulis J, Ausfeld-Hafter B, Windecker-Getaz I, Katsoulis K, Blagojevic N, Mericske-Stern T. Laser acupuncture for myofascial pain of the masticatory muscles. A controlled pilot study. *Revue Mensuelle Suisse d'Odonto-Stomatologie* 2010; 120(3): 213-225.

Mazzetto 2010

Mazzetto MO, Hotta TH, Pizzo RC. Measurements of jaw movements and TMJ pain intensity in patients treated with GaAlAs laser. *Brazilian Dental Journal* 2010; 21(4): 356-360.

Shirani 2009

Shirani AM, Gutknecht N, Taghizadeh M, Mir M. Low-level laser therapy and myofascial pain dysfunction syndrome: a randomized controlled clinical trial. *Lasers in Medical Science* 2009; 24(5): 715-720.

Smith 2006

Smith P, Mosscrop D, Davies S, Sloan P, Al-Ani Z. The efficacy of acupuncture in the treatment of temporomandibular joint myofascial pain: a randomised controlled trial. *Journal of Dentistry* 2006; 35(3): 259-267.

Other references

A.D.A.M 2014

Fotek I. T MJ disorders. A.D.A.M. Medical Encyclopedia February 25, 2014.

Cairns 2010

Cairns BE. Pathophysiology of TMD pain - basic mechanisms and their implications for pharmacotherapy. *Journal of Oral Rehabilitation* 2010; 37: 391-410.

Chung et al. 2011

Chung H, Dai T, Sharma SK, Huang YY, Carroll JD, Hamblin MR. The Nuts and Bolts of Low-Level Laser (Light) Therapy. *Annals of Biomedical Engineering* 2012; 40(2): 516-533.

de Moraes Maia et al. 2012

de Moraes Maia ML, Bonjardim LR, Quintans JSS, Ribeiro MAG, Maia LGM, Conti PCR. Effect of low-level laser therapy on pain levels in patients with temporomandibular disorders: a systematic review. *Journal of Applied Oral Science* 2012; 20(6): 594-602.

el Sayed and Dyson 1996

el Sayed SO, Dyson M. Effect of Laser Pulse Repetition Rate and Pulse Duration on Mast Cell Number and Degranulation. *Lasers in Surgery and Medicine* 1996; 19(4): 433-437.

Ernst 2006

Ernst E. Acupuncture - a critical analysis. *Journal of Internal Medicine* 2006; 259: 125-137.

Gray et al. 2003

Gray RJM, Davies SJ, Quayle AA. A Clinical Guide to Temporomandibular Disorders. Vol. 1. Suffolk: Dennis Barber Ltd., 2003.

Hashmi et al. 2010

Hashmi JT, Huang YY, Osmani BZ, Sharma SK, Naeser MA, Hamblin MR. Role of Low-Level Laser Therapy in Neurorehabilitation. *The Journal of Injury, Function and Rehabilitation* 2010; 2(12): 292-305.

Herranz-Aparicio et al. 2013

Herranz-Aparicio J, Vázquez-Delgado E, Arnabat-Domínguez J, España-Tost A, Gay-Escoda C. The use of low level laser therapy in the treatment of temporomandibular joint disorders. Review of the literature. *Medicina Oral, Patologia Oral y Cirugia Bucal* 2013; 18(4): 603-612.

La Touche et al. 2010

La Touche R, Goddard G, De-la-Hoz JL, Wang K, Paris-Alemany A, Angulo-Díaz-Parreño S, Mesa J, Hernández M. Acupuncture in the treatment of pain in temporomandibular disorders: a systematic review and meta-analysis of randomized controlled trials. *The Clinical Journal of Pain* 2010; 26(6): 541-550.

Lin 2008

Lin JG. Acupuncture Analgesia: A Review of Its Mechanisms of Actions. *American Journal of Chinese Medicine* 2008; 36(4): 635-645.

Melis et al. 2012

Melis M, Di Giosia M, Zawawi KH. Low level laser therapy for the treatment of temporomandibular disorders: a systematic review of the literature. *Cranio: The Journal of Craniomandibular Practice* 2012; 30(4): 304-312.

Mester et al. 1968

Mester E, Szende B, Gartner P. The Effect of Laser Beams on the Growth of Hair in Mice. *Radiobiologia, Radiotherpia* 1968; 9(5): 621-626.

Ohrbach 2010

Ohrbach R. Disability assessment in temporomandibular disorders and masticatory system rehabilitation. *Journal of Oral Rehabilitation* 2010; 37: 452-480.

Petrucci et al. 2011

Petrucci A, Sgolastra F, Gatto R, Mattei A, Monaco A. Effectiveness of low-level laser therapy in temporomandibular disorders: a systematic review and meta-analysis. *Journal of Orofacial Pain* 2011; 25(4): 298-307.

Posten et al. 2005

Posten W, Wrone DA, Dover JS, Arndt KA, Silapunt S, Alam M. Low-Level Laser Therapy for Wound Healing: Mechanism and Efficacy. *Dermatologic Surgery* 2005; 31: 334-340.

Rola et al. 2014

Rola, P, Doroszko A, Derkacz A. The Use of Low-Level Energy Laser Radiation in Basic and Clinical Research. *Advances in Clinical and Experimental Medicine: Official Organ Wroclaw Medical University* 2014; 23(5): 835-842.

Sutherland 2002

Sutherland JC. Biological Effects of Polychromatic Light. *Photochemistry and Photobiology* 2002; 76(2): 164-170.

Takano et al. 2013

Takano T, Chen X, Luo F, Fujita T, Ren Z, Goldman N, Zhao Y, Markman JD, Nedergaard M. Traditional acupuncture triggers a local increase in adenosine in human subjects. *The Journal of Pain: Official Journal of the American Pain Society* 2012; 13(12): 1215-1223.

Vickers et al. 2013

Vickers AJ, Cronin AM, Maschino AC, Lewith G, MacPherson H, Victor N, Foster NE, Sherman KJ, Witt CM, Linde K. Acupuncture for chronic pain: individual patient data meta-analysis. *Archives of Internal Medicine* 2012; 172(19): 1444-1453.

Wright and North 2009

Wright E, North S. Management and Treatment of Temporomandibular Disorders. *The Journal of Manual & Manipulative Therapy* 2009; 17(4): 247-254.

Yu et al. 1996

Yu XM, Sessle BJ, Haas DA, Izzo A, Vernon H, Hu JW. Involvement of NMDA receptor mechanisms in jaw electro-myographic activity and plasma extravasation induced by inflammatory irritant application to temporomandibular joint region of rats. *Pain* 1996; 68:169-178.

Data and analyses

Table 17: Low Level Laser Therapy vs Placebo Laser Treatment

Outcome or Subgroup	Studies	Participants	Statistical Method	Effect Estimate
1.1 Visual Analogue Scale (VAS) of the masseter muscles	8	241	Std. Mean Difference (IV, Fixed, 95% CI)	-0.29 [-0.55, -0.02]
1.2 Visual Analogue Scale (VAS) of the lateral pole of the condyle	3	106	Std. Mean Difference (IV, Fixed, 95% CI)	-1.02 [-1.45, -0.60]
1.3 Visual Analogue Scale (VAS) of the pre-auricular region	3	106	Std. Mean Difference (IV, Fixed, 95% CI)	-1.23 [-1.66, -0.80]
1.4 Visual Analogue Scale (VAS) of the external auditive meatus	3	106	Std. Mean Difference (IV, Fixed, 95% CI)	-1.21 [-1.66, -0.76]

Table 18: Real Acupuncture vs Sham Acupuncture Treatment

Outcome or Subgroup	Studies	Participants	Statistical Method	Effect Estimate
2.1 Visual Analogue Scale (VAS) on palpation	6	165	Std. Mean Difference (IV, Random, 95% CI)	-0.14 [-0.78, 0.50]